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1.	Your reference	RBT/P301763GB 30JUL02 E736925-1 C03126 P01/7700 0.00-0217491.0
2.	Patent application number *(The Patent Office will fill in this part)*	0217491.0
3.	Full name, address and postcode of the or of each applicant (*underline all surnames*)	Duckworth & Kent Limited Terence House 7 Marquis Business Centre Royston Road Baldock Hertfordshire SG7 6XL
	Patents ADP number (*if you know it*)	06741827003
	If the applicant is a corporate body, give the country/state of its incorporation	United Kingdom
4.	Title of the invention	OPHTHALMIC LENS DELIVERY SYSTEMS
5.	Name of your agent (*if you have one*)	**W. P. Thompson & Co.**
	"Address for service" in the United Kingdom to which all correspondence should be sent *(including the postcode)*	Eastcheap House, Central Approach Letchworth Herts SG6 3DS
	Patents ADP number *(if you know it)*	158003 ✓
6.	If you are declaring priority from one or more earlier patent applications, give the country and the date of filing of the or of each of these earlier applications and *(if you know it)* the or each application number	Country / Priority application number *(if you know it)* / Date of filing *(Day/month/year)*
7.	If this application is divided or otherwise derived from an earlier UK application, give the number and the filing date of the earlier application	Number of earlier application / Date of filing *(Day/month/year)*
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OPHTHALMIC LENS DELIVERY SYSTEMS

This invention relates generally to instruments for use in the insertion of an intraocular lens into an eye. It is necessary in certain ophthalmic surgical procedures to insert an intraocular lens through a small incision, such as in the phacoemulsification technique of removing cataracts.

In GB2335148B there is described an instrument for the insertion of an intraocular lens into an eye, which comprises a body portion having a longitudinal axis, a nose portion forward of the body portion and having a lumen through which the lens is arranged to pass, and a plunger movable through the body portion and the nose portion, wherein the nose portion is hingedly connected to the body portion and is movable between an open position in which it is pivoted out of alignment with the longitudinal axis and a closed position in which it is coaxial with the body portion, for the receipt of an intraocular lens therein in the open position.

In the open position the lens can be inserted and then the nose portion is closed and can be locked into place for the operation then of the plunger to dispense the lens from the nose portion.

In use of the aforesaid instrument the lens is folded by the shape of the encircling passageway as the plunger pushes it forwards into the lumen. This is in order to reduce its dimensions so that it can be inserted into a relatively short incision in the eye.

The lenses which have heretofore been available have all had a substantial amount of convexity and therefore thickness

in order to be able to achieve the required refractive results. However, thin lenses are now becoming available, which because of the material from which they are made can achieve the required powers of refraction with a greatly reduced lens thickness. Such lenses can have a thickness of as little as 0.4mm. Hydrophilic acrylic materials are among those which can be used.

There has also been a continuing desire on the part of ophthalmic surgeons to be able to use ever smaller incisions in the eye. However, the incision size has been dictated largely by the dimensions of the folded lens.

It is an object of the present invention to use thin lenses in such a way that they can be inserted into an incision of very small dimensions, for example of as little as 2mm.

Broadly in accordance with one aspect of the invention there is provided a method of preparing an ophthalmic lens for insertion into the eye which comprises rolling the lens into a tubular configuration. Preferably, the lens is then cooled to maintain its shape for subsequent insertion into the eye.

Also broadly in accordance with the invention there is provided a method of preparing an ophthalmic lens for insertion into the eye which comprises placing the lens on a receiving surface of an injection instrument, and rolling the lens into a tubular configuration in alignment with the longitudinal axis of the instrument for engagement by a plunger.

Preferably, after being rolled the lens is cooled so

that it will hold its rolled shape until it has been inserted into the eye, where the warmth of the body will cause it to unroll into its in-use configuration.

Broadly in accordance with the invention there is also provided a device for rolling an ophthalmic lens into a tubular configuration, which comprises a pair of members slidable one relative to the other, one of said members serving to receive and locate the lens, and the movement being arranged to cause rolling of the lens into the tubular configuration.

The present invention is particularly appropriate for use with the instrument described in GB2335148B, which can be thought of as a broken-barrel injector, with the nose pivotable through 90°.

Also in accordance with the present invention in an instrument of the type described in GB2335148B, the forward part of the instrument is provided with a carriage comprising a member slidable relative to the nose of the instrument, said member receiving and locating the lens and the movement being arranged to cause rolling of the lens into a tubular configuration.

The sliding motion is preferably effected transversely of the longitudinal axis of the instrument.

This rolling action is carried out with the nose portion closed. The nose portion is then broken open, for inspection and/or for the lens to be cooled, for example with BSS. The nose portion is then closed again and the rolled lens can be pushed forwards by the plunger through a bore in the lumen.

It has been found in practice that the lens can be

rolled so as to have an external diameter of as little as 1.3mm, which means that the bore in the lumen can have a diameter of about 1.4mm.

In order that the invention may be more fully understood, a presently preferred embodiment of lens delivery system in accordance with the invention will now be described by way of example and with reference to the accompanying drawings, in which:

Fig. 1 is a top plan view of an injector instrument embodying the lens delivery system of the present invention;

Fig. 2 is a side view of the instrument shown in Fig. 1, but with the plunger fully depressed after insertion of the lens;

Fig. 3 is a side view of part of the instrument shown in Fig. 1, to illustrate the internal mechanism of the plunger and push rod;

Fig. 4 is a side view of the nose portion of the instrument shown in Figs. 1 and 2;

Fig. 5 is the view on arrow V in Fig. 4;

Fig. 6 is a top plan view of the lens roller base of the lens delivery system of the present invention;

Fig. 7 is a side view of the lens roller base shown in Fig. 6;

Fig. 8 is the end view of the lens roller base shown in Figs. 6 and 7;

Fig. 9 is a side view of the main body of the instrument shown in Figs. 1 and 2; and,

Fig. 10 is a schematic drawing of a separate device for the rolling of a thin lens.

Referring first to Figs. 1 to 3, there is shown an instrument 10 for the insertion of an intraocular lens into an eye. This instrument functions generally in the manner as described in GB2335148B. The instrument 10 comprises a main body 12, which is shown in more detail in Fig. 9. At the forward end of the body 12 is a nose portion 14 which is pivotable through 90° between a closed position as shown in Figs. 1 and 2 and an open position (not shown). The pivoting movement takes place about a pivot pin 16 which is housed within a hole 18 (Fig. 9) in the forward end of the main body 12. Projecting rearwardly from the main body of the instrument is a plunger 20. The plunger is arranged to be depressed relative to a flange 22. Forwardly of the flange 22 is a bayonet fitting 24 incorporating a bayonet pin 26 (Fig. 1). This bayonet fitting enables the plunger, and the associated parts shown in Fig. 3 to be withdrawn from the main body 12 of the instrument for cleaning and sterilisation.

As shown in Fig. 3, forwardly of the plunger 20 and connected thereto is a centre rod or push rod 28 which is encircled by a spring 30. The plunger 20 and centre rod 28 are preferably made of PEEK material, which is particularly appropriate for use with a titanium instrument because of its smooth sliding movement over titanium surfaces. The plunger 20 is thus given a very smooth movement when it is depressed.

Referring briefly to Fig. 9, there is there shown the main body 12 of the instrument, with a part of the bayonet fitting 24 at its rearward end. The spring 30 is seated at

the forward end against an internal surface 32 within the main body and the centre rod 28 is arranged to pass through an internal bore 34 at the forward end of the main body 12. The forward end of the main body terminates in a projecting portion 36 which functions in association with the nose portion and with the lens delivery system which will now be described.

The lens rolling delivery system of the present invention will now be described. The delivery system comprises a lens roller base 38, which is shown in use in Fig. 1 and in more detail in Figs. 6 to 8. The lens roller base 38 is arranged to be slidable transversely to the longitudinal axis of the instrument 10. In Fig. 1, the lens roller base 38 is shown in its position of maximum extension to one side of the instrument. It is arranged to slide linearly across the instrument when the nose portion 14 is closed. The lens roller base 38 comprises a rectangular block of PEEK material, a material chosen to slide smoothly relative to the adjacent surfaces of titanium or titanium alloy. The base 38 comprises a flat, relatively thin front portion 40, with a substantially thicker rear portion 42. Between these two portions is an intermediate stepped portion 44. The thicker rear portion 42 is provided with two bores 46 which receive respective pins 48 (Fig. 1). As shown in Fig. 1, these pins 48, when fitted into the bores 46, project slightly beyond the intermediate stepped portion 44 of the base.

The forward edge of the intermediate stepped portion 44 is shaped to define a concave recess 50 extending across the

width of the base 38. This recess can have a diameter of approximately 1.30mm. At the upper margin of the concave recess 50 is a land or "flat" at the top of the arc, indicated in Figs. 7 and 8 at 52. The purpose of this "flat" will be described hereinafter.

Referring now to Figs. 4 and 5, these show the nose portion 14 of the instrument. As mentioned above, the nose portion 14 is pivotable through 90° about pivot pin 16. The forward end of the nose portion 14 is shaped as a nozzle with an internal bore 54 through which the lens is pushed towards the incision in the eye. The rearward portion of the nose 14 is shaped to provide a longitudinally extending concave recess 56 between an upper horizontal surface 58 and a lower horizontal surface 60, as shown most clearly in Fig. 5. The diameter of the concave recess 56 is 1.30mm, i.e. the same as the diameter of the concave recess 50 in the lens roller base 38. The arrangement is such that the two concave recesses 50 and 56 are in alignment facing one another. As will also be appreciated from Fig.5, the centre of curvature of the concave recess 56 is coincident with the longitudinal axis of the bore 54 and of the injection instrument. The nose 14 is also provided with a pair of bores 62 which are dimensioned and positioned to receive the pins 48 projecting from the lens roller base.

In use, with the plunger 20 retracted as shown in Fig. 1, with the lens roller base 38 slid to the open side as shown also in Fig. 1, and with the nose 14 closed, a thin lens 64 is placed on flat surface 66 of the lens roller base 38 with its periphery within the concave recess 50. With the

nose portion 14 still closed, the lens roller base 38 is pushed transversely relative to the longitudinal axis of the instrument so that it slides relative to the nose portion 14. As the lens 64 approaches the concave recess 56 in the nose 14 its periphery will engage the surface of this recess and will begin to roll upwards around the inside of the recess. As the sliding movement continues, and as the two concave recesses approach one another, the rolling edge of the lens will strike against the land 52 at the upper margin of the concave recess 50 in the lens roller base and will be brought to a stop. Continuing closure movement will then cause the lens to be rolled up within the cylindrical cavity defined by the two convex recesses 50 and 56. The lens will be rolled into a spiral within this cavity. The rolled lens will then have a diameter of approximately 1.3mm. When the lens roller base 38 has been advanced to its maximum distance, the projecting pins 48 will be located within the bores 62 in the nose 14. A check stop 68, formed as a pin, then holds the nose 14 and lens roller base 38 in their engaged position. With the two components thus engaged, the nose 14 can be "broken open", i.e. pivoted through 90°, thus opening up the rearward end of the nose and enabling the rolled lens within its cylindrical cavity to be inspected. Desirably, the rolled lens is then also sprayed with a coolant, such as BSS, which causes it to become more rigid and to retain its shape for subsequent insertion through the lumen of the nose. After visual inspection and/or cooling of the lens, the nose 14 is pivoted back into its closed position. The lens 64 which is then positioned axially within the instrument can

then be pushed forwards by depression of the plunger 20. Depression of the plunger 20 causes the leading end of the centre rod 28 to engage the lens and push it forwards through the bore 54 into an incision in the eye. Desirably, one can provide a viscous material between the lens 64 and the leading end of the centre rod 28 in order to provide a more resilient contact. The leading end of the centre rod 28 is flat.

After insertion of the lens 64 the check stop pin 18 is released and the lens roller base 38 can be slid back into its initial, receiving position.

Although the lens rolling delivery system of the present invention has been described above in relation to its use with an instrument of the type described in GB2335148, it is to be understood that it is not limited to that particular type of instrument. For example, the lens rolling system could be used with an injection instrument which does not have a pivotable nose but which is designed to be loaded at its forward end with a lens for injection. In this case, a separate lens rolling device can be used, and the lens once rolled can then be loaded into the injection instrument by the use of a suitable transfer device such as forceps. It is therefore within the scope of the present invention to provide a lens rolling device, such as shown for example in Fig.10, which comprises two members 70, 72 which can be formed as blocks slidable relative to one another. The lower block 72 is provided with a concave recess 74 and the upper block 70 is provided with a corresponding concave recess 76. At the top of the arc of concave recess 74 there is provided

a land 78 or "flat" which serves as an abutment surface for the rolling lens which is positioned within the cavity defined between the two blocks. Depending upon the structure of the device, one or both of the blocks 70, 72 can be arranged to slide. Once a lens has been positioned between the two blocks and has been rolled by the sliding movement of the blocks, the blocks can be opened in a suitable manner to enable the rolled lens to be removed for transfer to the injection instrument, preferably after cooling to enable the lens to retain its shape.

Although the invention has been described above in relation to a thin lens which can be rolled to a diameter of about 1.30mm, the invention is not to be regarded as being limited to any particular dimensions. Similarly, the invention is not be regarded as limited to lenses of any particular material. The invention is applicable to all lenses which are capable of being rolled in the manner described above.

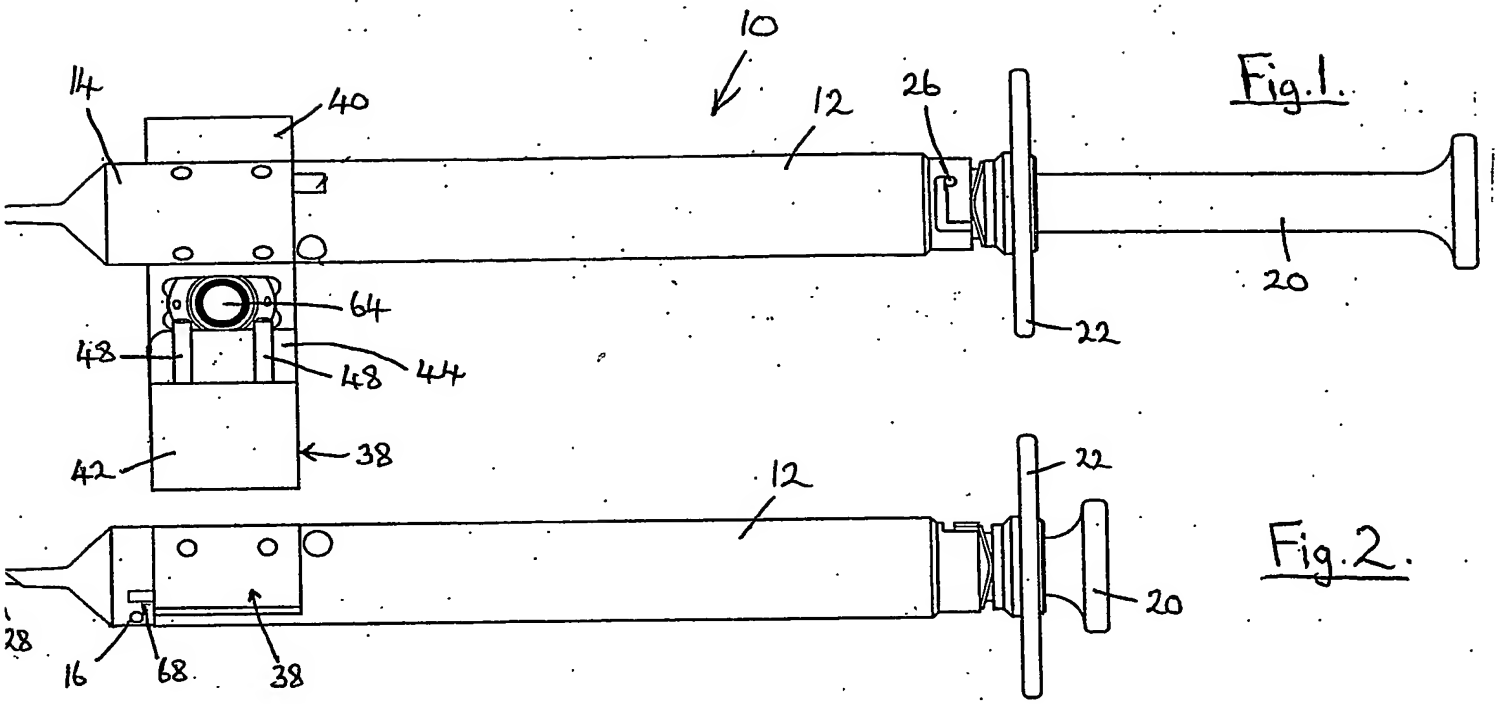

Fig.1.

Fig.2.

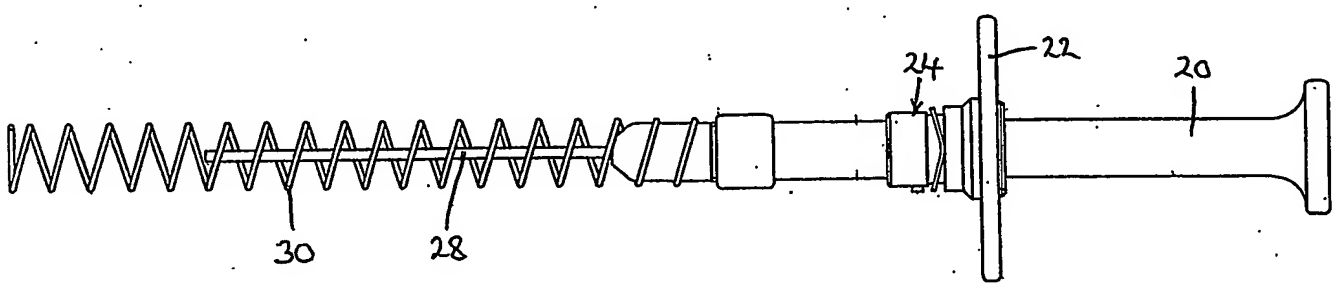

Fig.3.

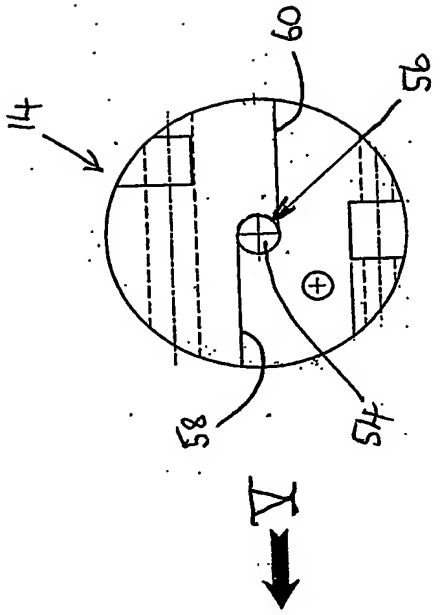

Fig. 5.

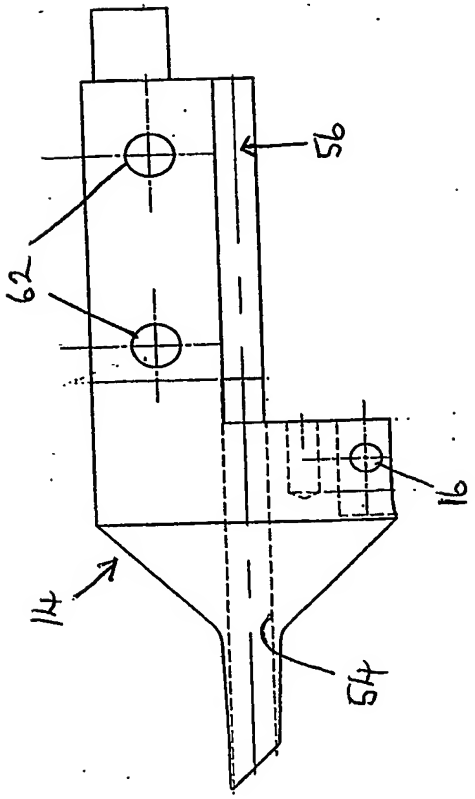

Fig. 4.

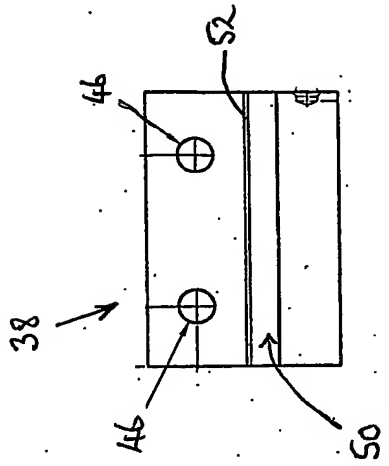

Fig. 8.

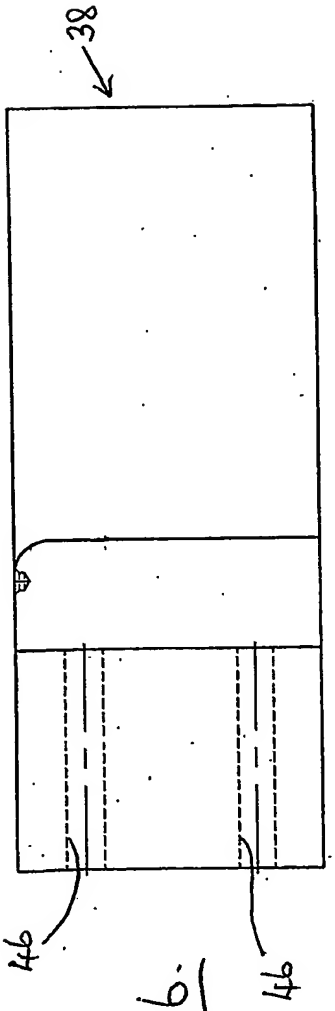

Fig. 6.

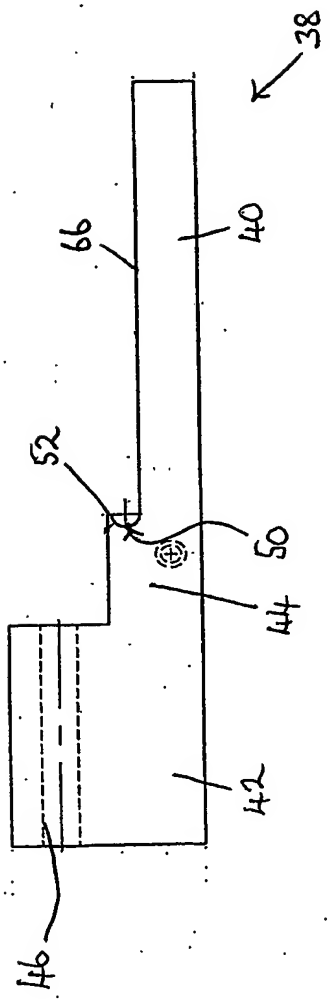

Fig. 7.

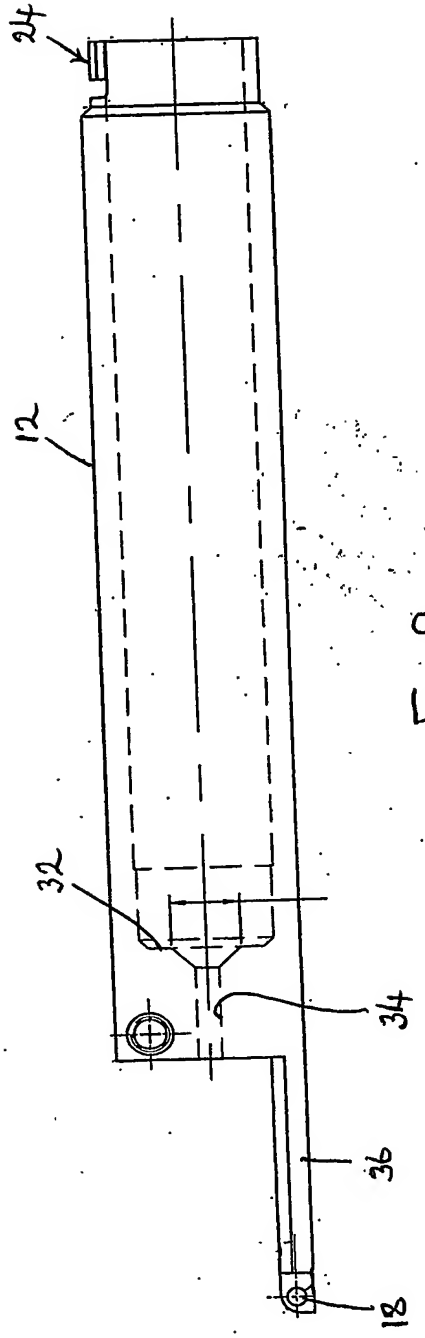

Fig. 9.

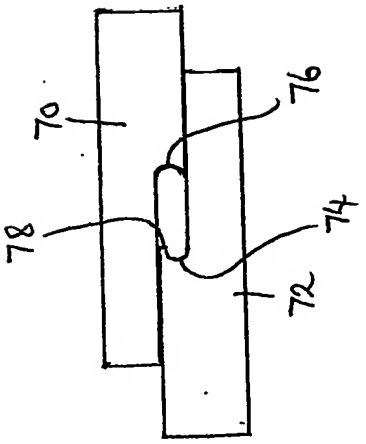

Fig. 10.

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